FORT BELKNAP BROWNFIELDS TRIBAL RESPONSE PROGRAM
TARGETED PHASE II ESA REPORT

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LIST OF ACRONYMS

ASTM	American Society for Testing and Materials
BIA	U.S. Bureau of Indian Affairs
BNA	base/neutral/acid
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
EPA	U.S. Environmental Protection Agency
ESA	Environmental Site Assessment
FBEPD	Fort Belknap Environmental Protection Department
FBIC	Fort Belknap Indian Community
FEMA	Federal Emergency Management Agency
FSP	field sampling plan
GPS	global positioning system
HASP	Health and Safety Plan
IDW	investigation derived waste
OAL	Old Agency Landfill

PA	preliminary assessment
PCB	polychlorinated biphenyls
PRG	Preliminary Remediation Goals
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RAS	regular analytical services
REC	Recognized Environmental Conditions
RPD	relative percent difference
SAP	sampling and analysis plan
SOP	standard operating procedure
SVOC	semivolatile organic compound
VOC	volatile organic compound

EXECUTIVE SUMMARY

Portage Environmental, Inc. (Portage) was contracted by the Fort Belknap Indian Community (FBIC) to perform a Targeted Phase II Environmental Site Assessment (ESA) for the Old Agency Landfill (OAL). The Targeted Phase II ESA is funded by a Brownfields Tribal Response Grant, administered by the United States Environmental Protection Agency (EPA).

The OAL is located at the west side of the town of Fort Belknap Agency, less than a quarter mile south of the Milk River (which forms the northern boundary of the Fort Belknap Indian Reservation). The landfill was used for over 60 years, primarily by federal agencies serving residents on the Fort Belknap Indian Reservation. The landfill accepted residential, agricultural, and industrial wastes (allegedly with materials containing pesticides and polychlorinated biphenyls - PCBs). The landfill closed in the 1960s.

The Targeted Phase II ESA work involved sampling and analysis of groundwater, soil and sediment to assess the potential presence or absence of contaminants of concern. Contaminants of concern were identified in earlier Phase I and Phase II ESAs performed by Portage in 2002. The results of the Targeted Phase II ESA will be used to support decisions regarding further site assessments and/or corrective actions, and future land uses.

A Targeted Phase II ESA Work Plan was prepared for the OAL based on recommendations found within the 2003 Phase II ESA Report. Specific recommendations included further investigation of the area near TP-4 (that contains a tarlike substance on the surface) and installing/sampling additional groundwater monitoring wells.

The Targeted Phase II ESA Work Plan was implemented during the period of November 2005 through January 2006. Six soil samples, three sediment samples, and three groundwater samples were collected from the targeted locations. All were analyzed for the potential contaminants of concern (pesticides/PCBs, semivolative organic compounds – SVOCs, and metals). One background soil sample was collected and analyzed for metals. Additionally, duplicate soil and groundwater samples were collected and analyzed for the contaminants of concern.

Based on targeted sampling and analysis of surface and subsurface soils, the results indicate lower metals concentrations at depth. Targeted sampling of surface and subsurface soils at three locations just outside the tar stained soil area showed traces of pesticides in surface soils at one location, and no detection of pesticides at depth. Based on the chemical characterization, soil classification, and groundwater hydrology at the OAL, it appears that the pollutants found within the OAL boundaries are not particularly mobile but that “hot spots” exist, where higher concentrations of metals and/or pesticides can be found.

Field screening with the PID indicated the presence of volatile organic compounds (VOCs) at depth in the vicinity of groundwater monitoring well OAL-05. Sampling OAL-05 for VOCs is therefore recommended. Past and present sediment samples from the oxbow pond show elevated metals and arsenic levels; additional sediment samples would delineate the extent of this concern but may have limited value for assessing ecological risks. Institutional controls (signs, fencing, etc.) are recommended at this time, pending a general site cleanup. Ultimately, the OAL site restoration goals may be achieved by removing the rubble pile and reclaiming the surface.

1.0 INTRODUCTION

This Targeted Phase II Environmental Site Assessment (ESA) report was prepared by Portage Environmental, Inc. (Portage) for the Fort Belknap Indian Community (FBIC) within the Fort Belknap Indian Reservation, North Central Montana. The Fort Belknap Indian Reservation is home to the Gros Ventre and Assiniboine Tribes, and is governed by FBIC Council members.

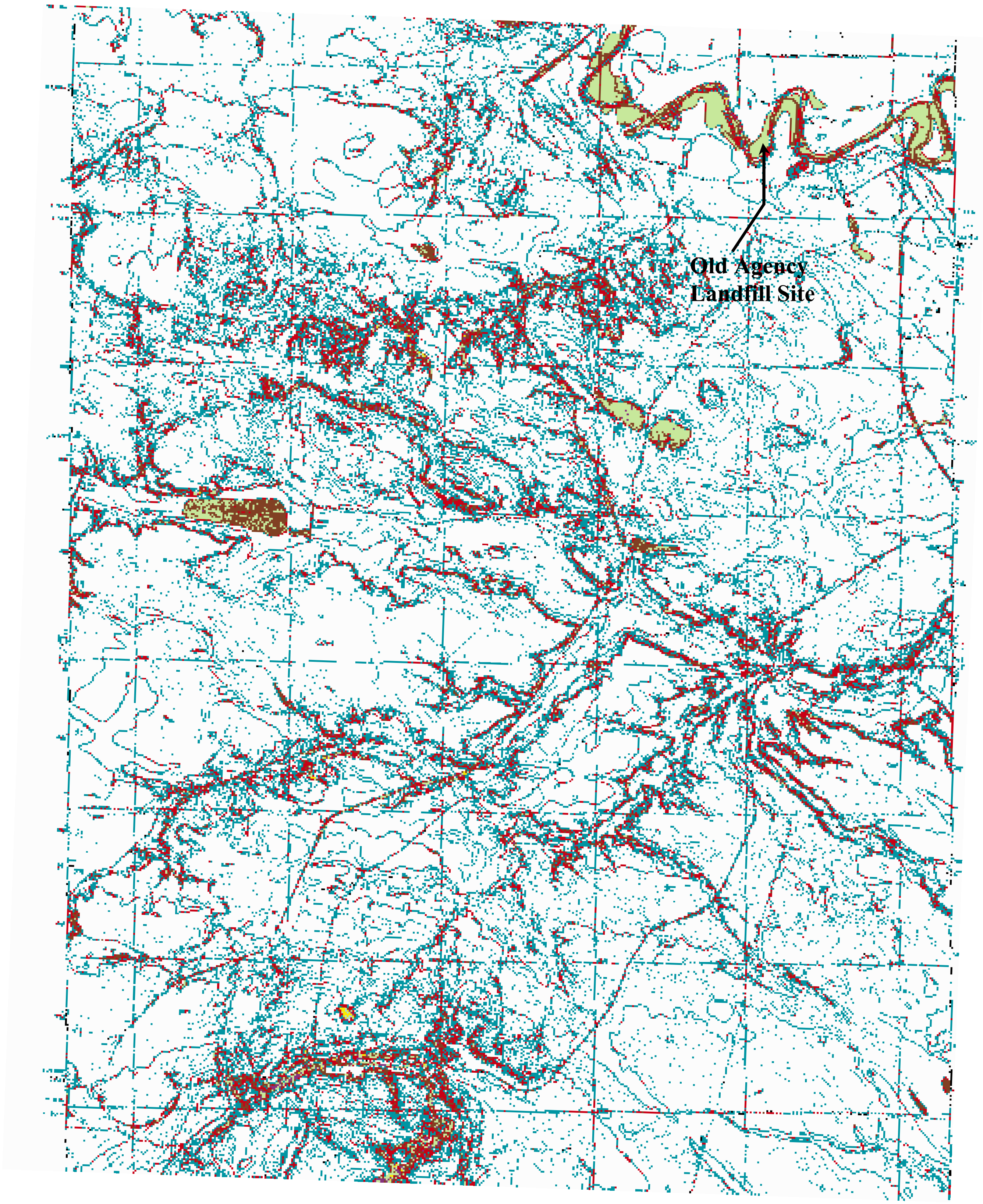
The Targeted Phase II ESA was conducted under a Brownfields Tribal Response Grant awarded to FBIC by the United States Environmental Protection Agency (EPA). The Fort Belknap Brownfields Tribal Response Program is being administered locally by the Fort Belknap Environmental Protection Department (FBEPD), with general oversight and federal administration by EPA in Helena, Montana. All ESA work is designed to meet federal requirements for work funded by an EPA Brownfields Grant, and work plans are submitted to EPA and FBEPD for review and approval.

Previous studies were conducted under a Brownfields Assessment Demonstration Pilot Project. The FBIC Brownfields Assessment Demonstration Pilot Project was primarily an environmental site assessment (ESA) conducted in three phases. The site is the Old Agency Landfill (OAL), located at the west side of the town of Fort Belknap Agency (Figure 1), proximate to the Milk River (which forms the northern boundary of the Fort Belknap Indian Reservation). The landfill was used for over 60 years, primarily by federal agencies serving residents on the Fort Belknap Indian Reservation. The landfill accepted residential, agricultural, and industrial wastes (allegedly with materials containing pesticides and polychlorinated biphenyls - PCBs). The landfill closed in the 1960s.

Phase I of the project involved a comprehensive review of available site data, site inspections, and reporting. The purpose of a Phase I ESA is to disclose factual environmental data and information in existence and identify Recognized Environmental Conditions (REC). Phase II ESA work, described in the 2003 ESA Report and this report, involves sampling and analysis of surface water, groundwater, and soil to further investigate the RECs identified in Phase I work and determine if EPA Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances are present. Phase III work is based on Phase II ESA findings and consultation with the Fort Belknap Environmental Protection Department (FBEPD) and EPA, and could include limited risk assessment and/or development of alternatives and costs for proposed corrective actions and future land uses.

The initial OAL Brownfields Assessment Demonstration Pilot Project was implemented and reported in the years 2002 and 2003. Results from the three-phase ESA indicated that additional data was needed to better define the extent of contaminants of concern. The Targeted Phase II ESA began in 2005 under the Brownfields Tribal Response Program. This report describes the purpose, procedures, and findings associated with the OAL Targeted Phase II ESA.

Figure 1. Project Location



1.1 Purpose

The purpose of the Targeted Phase II ESA was to further investigate RECs and potential contaminants of concern identified within the earlier Phase I and Phase II ESA reports (Portage/URS, 2002 and 2003). Specifically, the purpose of Phase II work was to gather data with which to verify the presence (or absence) of CERCLA hazardous substances that may exceed published limits within primary exposure pathways (soil and water) at the OAL.

A Phase II ESA Work Plan (Portage, 2005) including a Quality Assurance Project Plan (QAPP), Field Sampling Plan (FSP), and Health and Safety Plan (HASP) was used as the basis for all Targeted Phase II ESA activities. The QAPP contains the required information for approval by EPA and follows EPA 540-R-98-038 *Quality Assurance Guidance for Conducting Brownfields Site Assessments*. The FSP includes key components for sampling and data gathering found in American Society for Testing and Materials (ASTM) Designation: E 1903 – 97 *Standard Guide for Environmental Site Assessments: Phase II Environmental Site Assessment Process* as well as in EPA 540-G-89-004 *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. Combining the QAPP and FSP into the Phase II Work Plan essentially constitutes a SAP as defined by CERCLA guidance. The Work Plan also included a project-specific HASP following regulations promulgated under OSHA 29CFR 1910.120 *Hazardous Waste Operations and Emergency Response*.

The key tasks completed for the Targeted Phase II ESA included the following:

- Develop an accurate site map depicting relevant information from past and present ESAs;
- Develop a Targeted Phase II ESA Work Plan to implement earlier recommendations;
- Sample soils and sediments at biased locations to determine if contaminants are present;
- Install three new groundwater monitoring wells;
- Test groundwater monitoring wells to assess groundwater flow velocity and direction; and
- Sample groundwater from the three new groundwater monitoring wells.

Additional detail on the development of these tasks, project organization, and problem definition including descriptions of conceptual models and sampling rationale for OAL is found in the Targeted Phase II ESA Work Plan. The Work Plan also includes descriptions of all Standard Operating Procedures (SOPs) for Quality Assurance/Quality Control (QA/QC) and for sampling and handling protocols. The subsequent sections of this Targeted Phase II ESA report describe the activities, results and analyses of data collected from Targeted Phase II ESA work. These are presented under the main category headings as follows:

- Background
- Targeted Phase II Activities
- Evaluation and Presentation of Results
- Conclusions and Recommendations
- References

2.0 OLD AGENCY LANDFILL BACKGROUND

This section provides background information for the Old Agency Landfill, including the site description, physical setting, history, summary of previous assessments, and adjacent land use.

2.1 Site Description and Physical Setting

The Old Agency Landfill (OAL) is located on property owned by FBIC at the southwest side of the town of Fort Belknap Agency, in the NE ¼ of the SW ¼ of Section 32, T32N, R23E, Principal Montana Meridian, Blaine County, Montana (Figure 1). The landfill encompasses an area of approximately five acres. The landfill is approximately bounded to the north by an oxbow pond associated with the Milk River, to the east by two ponds constructed for the town's water treatment system, to the south by Tribal Construction offices and equipment storage areas, and to the road that runs parallel to a fenced runway used for small aircraft. The south side of the landfill also contains an elongated pile of apparent demolition waste (concrete and scrap iron) mixed with soil material. The waste pile is oriented approximately northwest-southeast, parallel and northeast of the road, and varies in height and width. Figure 2 is a site map of the landfill showing key physical features.

A paved road is located between the town of Fort Belknap Agency and the water treatment plant, and the landfill is accessed by an unimproved road extending west of this road. The landfill also has two unimproved vehicle trails within its approximate boundaries. Maxim Technologies, Inc. constructed three monitoring wells (OAL-01, OAL-02 and OAL-03) at the landfill in 2000 as part of a previous site assessment (Maxim, 2000). The landfill is approximately 1,000 feet south of the Milk River, and approximately 0.25 mile upstream of the intake for the community's drinking water system.

The landfill has reportedly not been used since the 1960s. Consequently, the area has a relatively thick vegetative cover consisting primarily of grasses and scattered shrubs. The oxbow pond has an extensive wetland fringe comprised predominantly of cattail.

The OAL is located in a relatively flat area characterized by river alluvial/floodplain and glacial drift deposits overlying older sand, silt and clay of Judith River Formation (Alverson, 1965). A review of the Federal Emergency Management Agency (FEMA) national flood insurance program's flood insurance rate maps for the Fort Belknap Indian Reservation, Montana shows the landfill to be within a 100-year floodplain.

FIGURE 2 IS SHOWN ON THE 11" X 17" INSERT FOLLOWING THIS PAGE.

Groundwater immediately beneath the landfill is unconfined and is expressed at the land surface by the water level in the adjacent oxbow pond along the northern border of the landfill. The water table depth varies within the landfill. The water table is approximately seven feet below the land surface within the central portion of the landfill based on water level measurements from the onsite wells, and gradually decreases in depth towards the oxbow pond to the north. Exploratory test pits excavated between the monitoring wells and oxbow pond encountered groundwater from four to six feet below the land surface along the northern side of the landfill.

2.2 Site History and Summary of Previous Assessments

The OAL was in operation for approximately 60 years before shutting down in the 1960s. The landfill allegedly accepted PCBs and pesticides in addition to construction and household refuse. This site initially became a concern to FBIC because a sheen was observed by the water intake for the community's potable water plant downstream of the landfill. Other exposure risks are from contact with contaminated soils or inhalation of dust. Many community members also use the area near the site for recreation (hunting, fishing and hiking).

The site was identified in 1988 as part of the Region VIII Indian Land Site Discovery Program (EPA, 1989). Ecology and Environment, Inc. completed a preliminary assessment (PA) in January 1990 (Ecology and Environment, 1990) under contract with EPA. The PA noted potential PCB presence in the landfill, with groundwater and surface water as potential exposure pathways. A screening site investigation (medium priority site inspection) was recommended, and Ecology and Environment completed the investigation in July 1990 (Ecology and Environment, 1991) by collecting area soil, sediment, and surface water samples. The July 1990 site visit also noted four 55-gallon drums of poor integrity that had obviously leaked a black oily substance.

The July 1990 investigation collected and analyzed a total of 16 environmental samples (excluding quality control samples). Seven surface water samples were collected consisting of samples from the Milk River (including an upgradient background sample), the adjacent oxbow pond, and the water treatment plant intake pond. Four shallow soil samples (within six inches of the land surface) of the landfill area were collected including a background sample and a sample of potentially concentrated waste in the area of the four 55-gallon drums. Four Milk River sediment samples were collected including a background sample, and one sediment sample was collected from the shore of the oxbow pond. All samples were analyzed for volatile organics, base/neutral/acid (BNA) extractable organics, pesticide/PCB, and regular analytical services (RAS) inorganics. Key analytical findings were as follows:

- The water sample from the water treatment plant pond contained elevated copper (Cu), manganese (Mn) and sodium (Na). The plant uses copper sulfate in the pretreatment pond to control algae.
- Toluene was detected in sediment and soil samples, including the background soil sample.
- The oxbow sediment sample contained elevated aluminum (Al), barium (Ba), chromium (Cr), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni), potassium (K), vanadium (V), and Zinc (Zn).

- The soil sample from the drum spill area contained chrysene and elevated Al, Pb, V, and Zn.
- The water sample from the oxbow pond contained elevated magnesium (Mg) and K.
- Pb was detected at elevated concentrations in the oxbow sediment sample, an on-site soil sample, and in Milk River sediment samples.

Based on these analytical findings, the Ecology and Environmental (1991) concluded that Pb and toluene were "observed releases" in sediments of the Milk River downstream of the probable point of entry of landfill-related waste. Toluene and chrysene also were found in "large concentrations" in on-site surface soils. The two on-site wastes sources identified by the investigation consisted of the soils in the drum area, and generalized on-site surface soil contamination. An internal EPA memorandum (March 20, 1991 memo from Steve Yarbrough to Ron Bertram) however suggested "…the frequent documentation of toluene as a lab contaminant makes usage of this contaminant at least somewhat questionable."

Upon completion of the screening site investigation, EPA determined that the landfill did not have the potential to score high enough for consideration as a National Priority List (NPL) site under CERCLA based on the small quantity of wastes and the relatively few targets. The site was declared "No Further Remedial Action", and FBIC became the lead agency for the site. This designation does not preclude EPA's Emergency Response Branch from taking action at the facility if necessary.

In 1999, FBIC received a Clean Water Act Section 106 Special Programs Grant from EPA to conduct a final assessment of the OAL. The objective of the final assessment was to determine impacts to surface water and groundwater from the landfill. During the course of the final assessment, Maxim Technologies, Inc. constructed three shallow (less than 20-feet deep) groundwater-monitoring wells at the landfill, and collected surface water (oxbow pond) and groundwater samples (from the new wells) for analyses of metals and organic constituents including pesticides and PCB. The results of this work (Maxim, 2000), and subsequent sampling by FBEPD personnel, showed that groundwater within the area of the landfill contains detectable concentrations of metals (with apparently elevated levels of sulfate and iron), but there were no detectable levels of organic chemical contaminants. Maxim attributed the elevated sulfate concentrations to the high sulfate content of the Judith River Formation underlying the site.

2.2.1 2002 Phase I ESA

Assisted by FBEPD personnel, Portage and URS conducted a Phase I ESA of the OAL in the spring of 2002 (Portage/URS, 2002a). The Phase I work noted that the landfill is still being used for construction/demolition waste. Large concrete manhole vaults were observed as well as freshly dumped soil. Older construction demolition waste also was observed near the northeastern edge. A patch of tar-like substance (approximately 15-feet by 4-feet) was observed approximately twenty feet south of the oxbow lake. Based on the site sample location map by Ecology and Environmental (1991), this area does not coincide with the location of the four drums that were observed to be leaking a black oily substance.

Key individuals at Fort Belknap with historic site knowledge were interviewed and shown aerial photos from 1956 and 1997. Some interviewees, when presented with the aerial photos, remember the OAL as existing in a different area, suggesting the landfill was further east than the area previously investigated. However, one source that worked for the Indian Health Service for many years, recalls the landfill as being located within the project area, but oriented along the oxbow lake.

The Phase I interviews also indicated that the sedimentation and backwash evaporation ponds for the water treatment plant were constructed approximately 30 years ago, and lined with bentonite clay. The edges of the ponds are sprayed with copper sulfate to minimize weed/algae growth, and the plant uses Liquid Alum (aluminum sulfate) as a coagulant in the water treatment process. Water from the backwash evaporation pond is frequently discharged into the oxbow lake.

Key findings from the Phase I ESA used as the basis for the Phase II work are as follows:

- Records reviewed indicate that OAL collected agricultural and residential wastes, potentially including pesticide and PCB wastes, for approximately 60 years. Interviewees reported the heavy use of pesticides in the area, particularly mosquito suppression in and around the oxbow pond and river. Although PCBs and pesticides are not REC's, past reports indicated their possible presence. Analytical testing in the past was relegated to surface water, shallow ground water, and shallow soil (within six inches below the land surface). There had been no sampling of soil deeper than six inches.
- Sampling results from the final screening site assessment conducted by Ecology and Environment indicate the presence of toluene, chrysene, lead, aluminum, vanadium and zinc in elevated concentrations in surface soils; elevated toluene and lead were noted in the Milk River sediments; and elevated copper was noted in the surface water samples. The screening site assessment also noted four overturned and leaking 55-gallon drums.
- Interviews with key individuals indicate that the actual landfill location may extend beyond the boundaries reported in prior studies. Some interviewees indicate that the landfill may extend up to 250 feet west of the site. One reliable source indicated that the landfill is oriented parallel to the oxbow lake. This was pointed out on a 1956 aerial photograph.
- Further site characterization and environmental sampling of OAL is warranted.

2.2.2 2002 Phase II ESA

In 2002, a Phase II ESA was implemented. Based on the Phase I findings and upon development of a conceptual site model, a sampling plan for Phase II OAL field activities was designed to verify the presence or absence of contaminants in soils. Previous sampling detected limited contamination in surface soils and sediment, but did not confirm contamination of landfill wastes in subsurface soil (no subsurface samples collected), surface water or groundwater. As suggested by a 1990 preliminary assessment (Ecology and Environment, 1990), the relative immobility of PCBs and other organic chemicals when in contact with clayey materials, may be the reason that these constituents were not detected in water samples. If this condition exists, it implies that there could still be contamination in subsurface soils that could create a potential hazard to human health and the environment.

The landfill boundaries and area of landfill wastes were not accurately determined before 2002. This raised the question as to whether the landfill groundwater monitoring wells were adequately located to enable detection of contamination from landfill leachate. Although groundwater monitoring did not show detectable levels of organic chemical contaminants, groundwater samples within the area of the landfill do show detectable concentrations of metals (with apparent elevated levels of sulfate and iron). Of interest is the variability of some groundwater quality parameters (e.g. pH, specific conductance and sulfate) over relatively short distances. This would imply that waste materials within the landfill could be impacting water quality on a localized scale.

Alternatively, the presence of the water treatment settling/backwash ponds adjacent to the landfill also could be impacting water quality. The Phase I ESA discovered that copper sulfate and aluminum sulfate are applied to the water in the ponds for weed control and as a coagulant, respectively. If the water quality in the landfill area is affected by the settling/backwash ponds, it also is conceivable that leakage from the ponds may be affecting the groundwater flow direction such that the landfill monitoring wells are not in the down-gradient path of landfill leachate.

Therefore, the preliminary objectives at the OAL were to better define the landfill boundaries and to determine if the existing monitoring wells are capable of detecting contaminated leachate from landfill waste. Once the boundaries were confirmed, and assuming the monitoring wells were properly located, the remaining tasks of the Phase II ESA investigation were to verify the presence or absence of pesticides, PCBs, VOCs, SVOCs, and metals within the soil matrix at depth and the presence or absence of pesticides, PCBs, SVOCs, and metals in surface soils.

Specific objectives for the 2002 Phase II sampling at the Old Agency Landfill were to:

- Define area of landfill wastes;
- Determine adequacy of existing groundwater monitoring wells for contaminant detection; and
- Determine presence or absence of pesticide, PCB, VOC, SVOC, and metals soil contaminants in known and suspected source areas.

The sampling design involved three main steps. The first was to delineate the extent of landfilled waste based on exploratory test pit excavations. The second was to determine groundwater flow direction by measuring water levels and sampling for signature parameters to determine the chemical relationship between groundwater wells and area surface water features. The third was based on the first step, and involved sampling subsurface and surface soils for potential contamination.

The Phase II ESA field work was executed by Portage in 2002. The Phase II ESA results indicated that there is detectable contamination within the landfill boundaries from metals, arsenic and organic chemicals associated with pesticides. There were no VOCs or PCBs detected in soils, and a SVOC was found in one soil sample. Several of the metal constituents (As, Ba, Cd, Cr, Ni, Ag, and Zn) found in soils exceed EPA Soil Screening Levels and one (As) exceeds Region 9 PRGs in multiple samples. Although arsenic levels were elevated from the background sample, the reported values are not high relative to naturally occurring arsenic found in many Montana soils.

Detectable levels of pesticides were found in three subsurface soils and three surface soils. The highest concentrations were found in subsurface soils approximately 30 feet from the oxbow pond. This suggests an increased risk of exposure in this area, and potential migration pathway from soils to sediments along the shore of the oxbow pond. For the purpose of examining this area further, Portage recommended additional soil and sediment characterization.

Analyses of groundwater samples collected from the monitoring wells indicate that the water quality beneath the landfill could be impacted from landfill wastes. Specific conductance, sulfate, Al, and Fe appear to be elevated above regional values.

The surface water sample collected from the oxbow pond did not show any impacts to water quality from the landfill. Based on the data from a limited number of surface water samples collected as part of the Phase II ESA and those analyzed in previous reports, it was reported that there is no evidence indicating that water quality at the Fort Belknap Agency drinking water intake has been affected by the landfill. Portage recommended installing one upgradient and two additional downgradient wells to further characterize groundwater quality and hydrology.

2.3 Adjacent Property Land Use

The Old Agency Landfill is located in an industrial part of the community on property owned by FBIC. Neighboring properties include:

- Bureau of Indian Affairs (BIA) maintenance and storage facilities located east, beyond the water treatment plant. These facilities are used for vehicle maintenance (ranging from motor vehicles to heavy equipment), above ground fuel storage, road maintenance supply storage, range supplies storage, and reportedly to store chemicals in buildings on the premises.
- Tribal Construction offices and storage facility are located to the southeast. Construction materials and Tribal vehicles and equipment are stored on the site.
- Community water system treatment plant and its two associated treatment ponds border the northeast side of the landfill.
- A runway used for small aircraft that borders the landfill to the southwest.

3.0 TARGETED PHASE II ACTIVITIES

In common with the 2002 Phase II ESA, the principal objective of the Targeted Phase II ESA field sampling is to gather sufficient data with which to evaluate whether CERCLA hazardous substances exceed published limits within primary exposure pathways (soil and water) at the Old Agency Landfill. This was accomplished by developing a work plan, performing field investigations such as sampling environmental media, analyzing samples for the chemical contaminants of concern, performing data validation and evaluation, and reporting the results.

The field portion of the investigation was completed in three visits to the Fort Belknap OAL. The first occurred during the week of November 1, 2005 and consisted of test pit excavations, surface and subsurface soil sampling, and sediment sampling. The second occurred during the week of December 19, 2005 and consisted of drilling and installing three new monitoring wells. Finally, groundwater monitoring wells were tested and groundwater samples were collected from the new monitoring wells during the week of January 2, 2006.

Targeted Phase II ESA activities followed the FSP and are based on the conceptual model of the OAL site (refer to Section 3.1.2) developed from earlier ESA work. Few deviations were made from the FS; these are reported in subsequent sections. The scope of the assessment and methodologies used for the Targeted Phase II activities are described in the sections below. Further details on the scope of assessment are found in the OAL Targeted Phase II ESA Work Plan (Portage, 2005).

3.1 Scope of Assessment

The following sections describe the scope of the Targeted Phase II ESA.

3.1.1 Record Review

The scope of the Targeted Phase II ESA included review of previous ESA reports showing analytical results of soil and water samples collected at OAL, historical documents and photographs on file with FBEPD, and other literature describing geological and hydrological conditions on the Fort Belknap Indian Reservation. These materials are referenced in the Phase I reports for OAL (Portage/URS, 2002a and 2002b) and, as appropriate, in this Phase II ESA report.

3.1.2 Conceptual Site Model and Sampling Plan

The Old Agency Landfill site conceptual model (Portage/URS, 2002b) includes:

Potential Sources of Contamination: The source of contamination is landfilled waste.

Possible Migration Pathways:

- Landfilled waste to soils: Contaminants found in landfilled waste may migrate to surrounding soils.
- Contaminated soils to groundwater: Contaminants may migrate from contaminated soils to groundwater.
- Contaminated groundwater to surface water and sediments: Contaminants may migrate downgradient from contaminated groundwater to nearby surface water (Milk River) and sediments.
- Contaminated soils to sediments: Contaminants may migrate from contaminated surface soils to the adjacent oxbow pond sediments. (Note: This is an addition to the earlier model.)

Possible Exposure Pathways:

- Direct contact to landfilled waste, contaminated soils, contaminated groundwater, contaminated surface water, or contaminated sediments. Human direct contact would most likely occur during construction activities near the landfill or during recreational use of contaminated areas. Ecological direct contact would most likely occur with indigenous species.

- Ingestion of contaminated soils, groundwater, surface waters, or sediments. Ingestion of contaminants would most likely occur either during recreational use of the area or by residential ingestion of contaminated drinking water. Ecological ingestion would most likely occur with indigenous species.

Receptors of Concern: For the residential scenario, humans may be exposed to contaminants through direct exposure to soils or by ingestion of contaminants by drinking water collected through the water intake downstream of the site. For the recreational scenario, humans may be exposed to contaminants through direct contact with contaminated surface soils. For the ecological scenario, waterfowl and aquatic life could be exposed to site contamination from pollutants transported via surface water and found within sediments. Additionally, construction workers may be exposed to contaminants by contact with both surface and subsurface soils.

3.1.3 Targeted Phase II ESA Sampling Plan

Environmental sampling data collected for the Targeted Phase II ESA at the Old Agency Landfill is evaluated based on the following:

- Comparison of soil data with EPA Region 9 Preliminary Remediation Goals and with EPA Soil Screening Levels; and
- Comparison of surface water and groundwater data with Circular WQB-7, Montana Numeric Water Quality Standards, January, 2004 specified limits, EPA Region 9 Preliminary Remediation Goals, and any Tribal water quality standards that have been developed by FBIC.

Specific sampling objectives associated with the Targeted Phase II EAS are described below.

- Examine the extent of contamination in the vicinity of surface soils stained with a heavy tar-like substance;
- Sample sediments in the oxbow pond for contaminants of concern (CoC's) to further evaluate the exposure pathway;
- Collect background concentration data for CoC's by sampling Milk River Sediments up-gradient of the site;
- Install two additional down-gradient monitoring wells with a screened interval extending from above the groundwater surface to approximately 10 feet below the groundwater surface to further evaluate the exposure pathway; and
- Install one up-gradient monitoring well and collect background concentration data for CoC's in groundwater.

These objectives are targeted to determine if an exposure pathway from contaminated site soils to wetland sediments and to groundwater is present. To fall within budget constraints, a limited number of samples were collected and submitted for analysis and a limited number of groundwater monitoring wells were installed. With the exception of the background sampling effort, locations which the FBIC and Portage believe to be most likely impacted were targeted for analysis.

3.1.4 Chemical Testing Plan

The chemical analytes for OAL samples include potential CoCs and signature parameters for groundwater. Soil, sediment, and groundwater were tested for the following analytes:

- Polychlorinated biphenyls (PCBs);
- Pesticides;
- Semi-volatile organic compounds (SVOCs), both acid and base-neutral extractable; and
- Metals including silver (Ag), arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), nickel (Ni), lead (Pb), and zinc (Zn).

Additionally, groundwater samples were tested for field parameters and sodium (Na), chloride (Cl), sulphate (SO_{4}), field specific conductance, field pH.

3.1.5 Field Explorations and Methods

Field explorations for the Targeted Phase II ESA included surface soil sampling, test pit excavation, soil sampling at depth, sediment sampling, installing groundwater monitoring wells, testing groundwater wells, groundwater sampling, and surveying. The specific types of field explorations and methods are described below.

Surface Soil Sampling: Surface soil samples were collected from three locations near the tar-stained area, in accordance with SOP No. 4 of the Work Plan. Hand tools were used to collect and containerize the samples. A fourth surface soil sample (for background metals) was collected approximately 1,000 feet south of the site, in undisturbed pasture land south of the aircraft runway.

Test Pit Excavation and Soil Sampling at Depth: Three test pits were excavated in close proximity to the tar-stained area. Figure 2 shows the test pit locations. The test pits were excavated using a 1987 Case 580E wheeled backhoe with an extendable hoe capable of reaching depths up to 15 feet below the ground surface. The pits were excavated by first removing and segregating the upper 12-inches of soil cover and placing this material to one side of the excavation, then excavating down to the desired sampling depth. Sampling was accomplished as specified in the Work Plan, by collecting a sample from the center of a backhoe bucket, after excavating to the selected sampling depth. Upon sampling and documenting subsurface conditions, each excavation was backfilled following the sequence of material removal, placing the topsoil last.

Sediment Sampling: Three sediment samples were collected in accordance with the Work Plan; one upstream of the site and within the Milk River high water mark, and two at the edge of the oxbow pond adjacent to the OAL. Sediment samples were collected by using a pre-cleaned Lexan push tube.

Installing Groundwater Monitoring Wells: Three new monitoring wells were installed by hollow-stem auger drilling methods. SK Geotechnical Corporation provided the equipment, materials, and labor (under subcontract to Portage) and installed the wells under the direction of Portage's onsite engineer. Monitoring wells were installed in accordance with the Work Plan, and developed by rapid and repeated surging with a plug tool.

Testing Groundwater Monitoring Wells: Limited tests were conducted on the six OAL groundwater monitoring wells. Testing consisted of pumping each well dry and measuring recovery rates. A small submersible 12-volt electric pump furnished by PFEPD was used to pump the water. Recovery rates were measured by using an electric water level indicator and watch. The tests also served as the purge for the wells that were sampled. Recovery test results are shown in Appendix B.

Groundwater Sampling: Groundwater samples were collected for laboratory analyses of potential CoCs and for measurement of field parameters to identify the chemical "signatures" of waters present on site. Both water chemistry and water elevation data were obtained to evaluate the hydrologic connection between surface water and groundwater, and the potential influence of the water treatment settling/backwash ponds on groundwater flow directions.

Prior to collecting groundwater samples from the three on-site wells, each well was first purged using the FBEPD's portable electric pump. The wells were pumped completely dry, and then allowed to recover overnight. This was done because the OAL well recovery times are slow to very slow, and sufficient sample volume was needed for the full suite of chemical analyses. Field parameters were measured prior to sampling by collecting groundwater with a disposable Teflon bailer, placing the sample in a clean glass jar, and then measuring pH, temperature, and dissolved oxygen. The Fort Belknap Community College furnished instruments for measuring groundwater field parameters; however, the specific conductivity meter was unavailable on the day samples were collected so there are no field specific conductivity readings. All samples collected for metals analyses were filtered by pumping the sample (with a peristaltic pump) through a 0.45 micron cartridge filter attached to the pump's discharge line.

Surveying: Test pits and new groundwater monitoring wells were surveyed by Portage and FBEPD personnel by conventional methods (optical level, rod, and tape measure). The elevations of surface water bodies and groundwater levels within the six OAL wells were surveyed to develop a potentiometric map of the site. The groundwater elevations were determined by measuring the depth to groundwater from the top of the inner well casing, then surveying the top of each inner well casing relative to a common datum. Measurements were taken from known reference points so that sampling locations and the new groundwater monitoring wells could be identified on the site map (Figure 2).

3.1.6 Field Documentation

Field activity documentation included field forms, field logbooks and site photographs (Appendix A). Field forms provided sample-specific documentation and descriptive detail on sample collection. Field forms were completed for each soil and water sample collected at OAL. Field logbooks were kept for all test pit, soil and water sampling activity. The logbooks provide a written record for all field data gathered, field observations and samples collected for laboratory analysis. They also ensure that field activities are properly documented and that site work was conducted in accordance with the Phase II ESA Work Plan. Selected test pits and all soil sampling points at OAL were documented using digital photographs to provide a visual record of stratigraphy and type of waste material present. Photographs were noted in the field logbook or on a field form.

3.1.7 Management of Investigation Derived Waste

Investigation derived waste (IDW) was managed according to the procedures described in the Targeted Phase II ESA Work Plan. Examples of investigation derived waste include decontamination fluids, personal protective equipment (PPE), and disposable sampling equipment. No RCRA regulated solvents or materials were used. PPE and disposable sampling equipment was disposed of as municipal solid waste.

Soil excavated from test pits at OAL was backfilled and graded to promote positive drainage away from the test pit. Topsoil was segregated during excavation and replaced as the surface soil layer. Prior to decontaminating the backhoe bucket used for soil sampling, all soil material adhering to the bucket and/or backhoe boom was scraped off and returned to the original excavation. Decontamination water was allowed to drain off of the equipment above the most recently excavated test pit prior to completing backfill of the uppermost 1-2 feet of soil. Likewise, when installing monitoring wells, drill cuttings and decontamination water were returned to onsite pits that were backfilled in the same manner as test pits.

3.2 Environmental Media Samples and Chemical Analyses

The following sections describe the samples collected and chemical analyses for soil, sediment and groundwater at OAL. Sample collection followed the OAL Targeted Phase II Work Plan procedures, as described in Section 3.1.

3.2.1 Surface Soil

A total of four surface soil grab samples were collected in undisturbed areas directly adjacent to test pit locations OAL-TP-4, OAL-TP-32 and OAL-TP- 33 (Figure 2). Three sample locations were within the area of the tar-like substance on the ground surface and the fourth (background metals) sample location was approximately 1,000 feet south of the OAL. All samples were collected by first removing the uppermost 1 to 2 inch organic layer, then obtaining representative soil material within the next one to two inches in depth (i.e. sample interval between 2 and 4 inches below the land surface). The samples were obtained using a large stainless steel spoon and placed in glass jars. The soil sampling field forms that document sampling activity are in Appendix 1, copies of entries in the field logbook are in Appendix 2, and site photographs are in Appendix 3. Sample designations and analytical parameters for the OAL Targeted Phase II ESA are shown on Table 1. Specific sample handling requirements for soil samples and SOPs used for sample collection and handling are in the OAL Targeted Phase II ESA Work Plan.

Table 1. Summary of OAL Targeted Soil, Sediment, and Groundwater Samples.

Sample ID/ Location	Sampling Rationale	Location Description	Sample Type	Number of Samples	Analysis Code	Matrix
OAL-SS10 OAL-SS12 OAL-SS14	Identify the presence or absence of contaminants of concern in surface soil	Perimeter of the tar-stained soil area	Grab	3	A, B, C	Soil
OAL-SS16	Evaluate background metals concentrations in surface soil	Approximately 1,000 feet south of the OAL	Grab	1	C	Soil
OAL-SS11 OAL-SS13 OAL-SS15 OAL-SS17*	Identify the presence or absence of contaminants of concern in subsurface soil	Perimeter of the tar-stained soil area	Grab	4*	A, B, C	Soil
OAL-SED1	Evaluate background concentrations of contaminants of concern in sediment	Upgradient of site and within the Milk River's high water mark	Grab	1	A, B, C	Sediment
OAL-SED2 OAL-SED3	Identify the presence or absence of contaminants of concern in sediment	At oxbow pond water's edge, downgradient of OAL	Grab	2	A, B, C	Sediment
OAL-04	Evaluate background concentrations of contaminants of concern and determine chemistry signature of groundwater	Monitoring well upgradient of OAL	Grab	1	A, B, C, D, and E	Groundwater
OAL-05 OAL-07**	Identify the presence or absence of contaminants of concern and determine chemistry signature of groundwater	Monitoring well downgradient of well OAL-01	Grab	2**	A, B, C, D, and E	Groundwater
OAL-06	Identify the presence or absence of contaminants of concern and determine chemistry signature of groundwater	Monitoring will downgradient of tar stained soil area	Grab	1	A, B, C, D, and E	Groundwater

Analysis Codes:
A: Pesticides/PCBs
B: SVOCs (acid and base-neutral extractable)
C: Metals: Arsenic (As), Barium (Ba), Cadmium (Cd), Chromium (Cr) , Lead (Pb), Nickel (Ni), Silver (Ag), Zinc (Zn)
D: Groundwater chemistry signature parameters: Iron (Fe), Sodium (Na), and Sulfate (SO_4)
E: Field Measurements: dissolved oxygen, pH, temperature, water elevation
*Subsurface soil sample OAL-SS17 is a duplicate of OAL-SS13.
**Groundwater sample OAL-07 is a duplicate of OAL-05.

3.2.2 Subsurface Soil

A total of three subsurface soil samples and one duplicate sample were collected from test pit locations (Figure 2) and analyzed for the parameters shown in Table 2. The test pit locations were based on criteria established in the Work Plan. The sample interval was based on visual observations of changes in subsurface material characteristics. The subsurface samples were collected using a backhoe by first excavating down to the saturated zone, collecting a sample of the native soil from just above the saturated zone using the backhoe bucket, then obtaining a representative sample of the soil from the center of a backhoe bucket using a decontaminated disposable spoon. Documentation of the soil sampling activities is shown in Appendix A. Soil material adhering to the backhoe bucket was first scraped off, and the backhoe bucket was washed with pressurized water between sampling locations using a portable tanker vehicle provided by FBIC. The rinsate water was then allowed to drain over the excavation before the final cover was replaced.

3.2.3 Sediment

Three sediment samples were collected in accordance with the Work Plan; one upstream of the site and within the Milk River high water mark, and two at the edge of the oxbow pond adjacent to the OAL. Sediment samples were collected by using a pre-cleaned Lexan push tube.

3.2.4 Groundwater

Three groundwater samples and one duplicate groundwater sample were collected from the new OAL groundwater monitoring wells, identified as OAL-04, OAL-05, and OAL-06. Groundwater samples were collected using diposable Teflon bailers. The sampling locations are shown on Figure 2, and the sample designations and analytical parameters are shown in Table 2. The sample handling requirements and SOPs used for sample collection and handling are found in the OAL Targeted Phase II ESA Work Plan.

3.3 Data Validation and Limitations

Analytical data were validated according to procedures found in the Targeted Phase II ESA Work Plan. Four data validation reports were prepared to address data for:

- Pesticides;
- Polychlorinated biphenyls (PCBs);
- Semivolatile organic compounds (SVOCs); and
- Inorganics.

Data validation reports are found in Appendix C, preceding the laboratory analytical results. The project completeness goal of 90% was met for all data. With the exception of sodium, as noted below, the duplicate relative percent difference goals were within acceptable limits. The following data limitations were noted in the data validation reports:

- The 4,4-DDT results for the sediment samples (OAL-SED1, OAL-SED2, and OAL-SED3) have been qualified with a "UJ" validation flag to denote the data is non-detectable at the reported value, and the reported value is an estimate due to imprecise quantitation limits.
- In groundwater samples (OAL-04 through OAL-07), all sodium sample results have been qualified with a "J" validation flag to denote that the data is detectable at the reported value, but the reported value is an estimate due to a high field duplicate relative percent difference (RPD) of 21.3%, as compared to 20% that is recommended for water samples.

4.0 EVALUATION AND PRESENTATION OF RESULTS

The information collected from the Targeted Phase II ESA was evaluated to determine the presence or absence of contamination and to verify/modify the conceptual models of OAL. The following sections describe the field and analytical results, and distribution of contaminants based on the laboratory analyses.

4.1 Field Measurements

4.1.1 Photoionization Detector (PID) Readings

Field screening for VOCs in soils was performed during test pit excavations and during installation of the new groundwater monitoring wells. The instrument used was a PE Photovac Photoionization Air Monitor, calibrated using 100 ppm isobutylene in air span gas. Table 2 lists positive readings that were observed during the Targeted Phase II ESA. Other sampling locations (not listed) did not show positive readings with the PID.

Table 2. Summary of Positive PID Readings.

Location	Depth (ft)	Associated Sample(s)	PID Reading (ppm)
TP-3, test pit north of tar-stained area	5.0 to 5.5	OAL-SS13 OAL-SS17 (duplicate)	36.6
OAL-05 monitoring well	3.5 to 5.0	-	0.5
OAL-05	6.0 to 7.5	OAL-05 OAL-07 (duplicate)	85.0
OAL-05	8.5 to 10.0	-	4.8

4.1.2 Groundwater Measurements

Groundwater monitoring wells were pumped dry as part of purging before sampling. Measurements were taken to record static water levels before each purge, the quantity of water removed to draw each well dry, and water levels during each well recovery. This information (see Appendix B) provides reference data for future groundwater sampling and general information for estimating the (uppermost aquifer) groundwater flow direction and velocity. Table 3 lists static water levels measured in the OAL wells and elevations for nearby surface waters, and Figure 3 shows generalized groundwater elevation contours. Field water quality parameters were measured with when collecting groundwater samples, using two instruments – a YSI 60 pH/Temperature meter and a YSI 55 Dissolved Oxygen/Temperature meter. (FBEPD personnel measured specific conductivity on 3/9/2006.) Results are summarized in Table 4.

NOTE: ELEVATIONS LISTED WITHIN THIS REPORT ARE ADJUSTED TO THE U.S. DEPARTMENT OF INTERIOR, BUREAU OF INDIAN AFFAIRS ESTABLISHED VERTICAL DATUM OF 2,362.17 FEET, FOUND AT THE SOUTWEST CORNER OF THE FORT BELKNAP AGENCY WATER TOWER, DATED 3-15-1961. ELEVATIONS BASED ON THIS VERTICAL DATUM ARE 4.02 FEET HIGHER THAN REPORTED BY MAXIM IN THE 2000 SITE ASSESSMENT REPORT.

FIGURE 3 IS SHOWN ON THE 11” X 17” INSERT FOLLOWING THIS PAGE.

Table 3. Water Elevations in OAL Wells and Nearby Surface Waters.

Nearest Sample ID	Type/Location	Date of Measurement	Elevation (feet, BIA datum)
OAL-01	Groundwater Monitoring Well	1/4/2006	2,339.76
OAL-02	Groundwater Monitoring Well	1/4/2006	2,342.00
OAL-03	Groundwater Monitoring Well	1/4/2006	2,339.11
OAL-04	Groundwater Monitoring Well	1/4/2006	2,344.42
OAL-05	Groundwater Monitoring Well	1/4/2006	2,339.18
OAL-06	Groundwater Monitoring Well	1/4/2006	2,339.16
OAL-SW1*	Surface Water, Oxbow Pond	1/4/2006	2,339.36
OAL-SW2*	Surface Water, Water Treatment Pond – East	9/26/2002	2,349.47
OAL-SW3*	Surface Water, Water Treatment Pond – West	1/4/2006	2,343.19
OAL-SW4*	Surface Water – Milk River	4/29/2002	2,336.49

***Surface water samples were previously collected from these locations in 2002; all vertical elevations are adjusted to the BIA water tower datum (see note above).**

4.2 Analytical Test Results

This section summarizes analytical test results for the targeted soil, sediment, and groundwater samples for the OAL.

4.2.1 Targeted Soil and Sediment Samples

The laboratory analytical data for metals in OAL surface and subsurface soil samples are shown in Table 5 and laboratory reports are found in Appendix C. For comparison purposes, Table 5 also includes EPA Region 9 Preliminary Remediation Goals (PRGs) for residential soils, EPA Soil Screening Levels, the results of a background surface soil sample collected by Ecology and Environment (1991) in the southeast corner of the landfill, and the background surface soil sample collected during this investigation.

The following is statements can be made based on a review of Table 5:

- It is uncertain whether some parameters (i.e., As, Cd, and Ag) are elevated because the laboratory detection limits are above the background values; although laboratory detection limits were above background, they were not above residential risk-based concentrations with the exception of arsenic;

- All soil and sediment samples have elevated levels of barium (Ba), typically around twice that of background; however, the levels are well below risk-based concentrations;

- The three targeted surface soil samples show elevated levels of chromium (Cr), lead (Pb), nickel (Ni), and zinc (Zn) in comparison to background samples, particularly in sample OAL-SS10; however, the surface metal concentrations (with the exception of arsenic) are below risk-based concentrations;

- Metals in the three targeted subsurface soil samples (and duplicate sample OAL-SS17) are generally close to background levels; and

- Sediment sample OAL-SED3 shows levels of arsenic (As) and lead (Pb) above EPA Region 9 PRGs and zinc (Zn) above the EPA soil screening level.

Table 4. Summary of OAL Water Quality Parameters and Signature Chemistry.

Sample ID	Sample Location	Field WQ Measurements				Chemical Signature Analyses (values in mg/L)					
		pH	Specific Cond. (μmhos/cm)	Temp. (°C)	D.O. (mg/L)	Cl	SO_4	Na*	Al	Cu	Fe**
Targeted Phase II ESA Results:											
OAL-04	Upgradient Monitoring Well	6.4	14,970	8.7	5.3	-	12,600	4,350	-	-	<0.01
OAL-05	Monitoring Well	5.6	20,290	7.2	6.5	-	26,900	10,800	-	-	0.32
OAL-06	Monitoring Well	5.4	16,560	8.0	1.5	-	11,500	3,560	-	-	<0.90
OAL-07	Duplicate of OAL-05	5.6	20,290	7.2	6.5	-	27,900	8,720	-	-	0.32
Previous Results from the OAL Phase II ESA:											
OAL-SW1	Oxbow Pond	8.6	912	15.8	-	28	281	169	0.2	<0.001	0.38
OAL-SW2	Water Treatment Settling (east) Pond	8.3	503	13.7	-	6	104	57	<0.1	0.041	0.26
OAL-SW3	Water Treatment Backwash (west) Pond	7.8	705	16.5	-	11	230	102	0.4	0.020	0.28
OAL-SW4	Milk River	8.2	378	12.6	-	<4	68	37	1.5	0.010	1.27
OAL-01	Monitoring Well	6.8	18,530	14.1	-	180	12,200	6,480	0.2	0.002	2.58
OAL-02	Monitoring Well	7.0	16,340	10.9	-	235	10,400	5,470	<0.1	0.006	0.04
OAL-03	Monitoring Well	5.5	13,130	10.2	-	52	8,130	3,150	1.1	0.004	10.5
Comparison with alluvial wells within 4-mile radius of OAL (Lawlor, 2000):											
W40	~4 mi. NW of OAL	8.7	2,690	-	-	33	730	630	<0.03	0.010	1.2
W41	~2.5 mi. NW of OAL	8.6	3,150	-	-	-	-	-	-	-	-
W43	~3 mi. NE of OAL	7.5	4,200	-	-	120	1,300	840	<0.03	0.015	5.8

***WQB-7 does not list a water quality standard for sodium (Na).**
****WQB-7 refers to the ARM for guidance on iron (Fe) standards and lists a secondary standard of 300 μg/L (0.3 mg/L) based on taste and smell.**

With one exception, analyses for pesticides, PCBs, and SVOCs in the targeted surface soil samples were below detection limits. Also with one exception, analyses for pesticides, PCBs, and SVOCs in the targeted surface sediment samples were below detection limits.

Low concentrations of 4,4-DDE and 4,4-DDT were detected in the targeted surface soil sample OAL-SS10. Low concentrations of 4,4-DDD and 4,4-DDE were detected in the targeted sediment sample OAL-SED3. (Note that 4,4-DDT data is "UJ" flagged in sediment samples). The concentrations of these pollutants are much lower than EPA Region 9 PRGs and Soil Screening Levels. Table 6 shows the detected pesticide levels and compares these concentrations with EPA Region 9 PRGs and Soil Screening Levels.

All analyses for pesticides, PCBs, and SVOCs in targeted subsurface soil samples were below detection limits.

Table 5. Summary of Metals Analyses for Targeted Soil and Sediment Samples.

Sample ID	Depth/Type	Inorganic Analyses Results (values in mg/kg)							
		As	Ba	Cd	Cr	Pb	Ni	Ag	Zn
Targeted Soil and Sediment Samples:									
OAL-SS10	Surface soil	<10	257	<2	26	52	23	<5	127
OAL-SS11	Soil at depth	10	235	<2	13	17	18	<5	73
OAL-SS12	Surface soil	<10	297	<2	26	28	25	<5	98
OAL-SS13	Soil at depth	<10	189	<2	11	<10	14	<5	50
OAL-SS14	Surface soil	<10	308	<2	23	20	26	<5	98
OAL-SS15	Soil at depth	<10	237	<2	12	10	18	<5	63
OAL-SS17	Duplicate of OAL-SS13	<10	202	<2	12	<10	15	<5	49
OAL-SED 1	Sediment	<10	202	<2	14	11	17	<5	62
OAL-SED 2	Sediment	<10	255	<2	20	39	20	<5	77
OAL-SED 3	Sediment	12	172	<2	27	838	31	<5	662
Values for Comparison:									
EPA Region 9 PRG Residential	All soils	0.39	5,400	37	210	400	1,600	390	23,000
EPA Soil Screening Level	All soils	1	82	0.4	2	-	7	2	620
OAL-SS16 (Background)	Surface soil	<10	157	<2	13	<10	13	<5	52
Background (1991)*	Surface soil	6.2	131	0.7	8.6	9.1	11.6	0.58	35.6

***Refers to background data as reported by Ecology and Environment (1991), for one soil sample collected from the southeast corner of the site, within six inches of the surface.**

Table 6. Summary of Pesticides Detected in Soil and Sediment Samples.

Sample ID	Depth/Type	Location	Pesticides Analyses Results (values in µg/kg)		
			4,4-DDD	4,4-DDE	4,4-DDT
OAL-SS10	Surface soil	NE of and near tar stained area	-	25	17
OAL-SED3	Sediment	Oxbow pond edge near well OAL-05	13	21	-
Comparison to PRGs and SSLs:					
EPA Region 9 Residential PRG	All soils	-	2,400	1,700	1,700
EPA Soil Screening Level	All soils	-	800	3,000	2,000

4.2.2 Groundwater Samples

Metals analyses of the targeted groundwater samples show very low concentrations, with many of the analytes close to or below detection limits. None of the metals that were tested exceed the Montana drinking water standards, tabulated in WQB-7. Table 7 summarizes results from the metals analysis and shows a comparison to Montana drinking water standards.

Secondary drinking water standards for iron (Fe), for taste and smell, are surpassed by the concentrations found in all wells except OAL-04 (refer to Table 4). The primary iron standards are based on a category assigned by the state and "no further degradation" without a specific standard based on human health. The sodium concentration in OAL-05 is very high; however, data for this sample is "J" flagged, reflecting that this is an estimate.

Table 7. Summary of Metals Analyses in Targeted Groundwater Samples.

Sample ID	Location	Inorganic Analyses Results (values in mg/L)							
		As	Ba	Cd	Cr	Pb	Ni	Ag	Zn
OAL-04	Well OAL-04	0.005	<0.05	<0.0005	<0.005	<0.003	0.02	<0.003	0.02
OAL-05	Well OAL-05	<0.005	<0.05	0.0007	<0.005	<0.003	0.07	<0.003	0.10
OAL-06	Well OAL-06	0.006	<0.05	<0.0005	<0.005	<0.003	0.03	<0.003	0.03
OAL-07	Well OAL-5 (duplicate)	<0.005	<0.05	0.0008	<0.005	<0.003	0.07	<0.003	0.10
Comparison to State of Montana WQB-7 Standards for Drinking Water:									
WQB-7	-	0.02	2.0	0.005	0.1	0.015	0.1	0.1	2.0

The elevated concentrations of constituents present in OAL groundwater could be derived from non-natural sources related to landfill wastes. This is demonstrated by the variability in pH and Fe and Al concentrations measured in groundwater from onsite wells. Since the wells are completed at approximately the same depth in essentially the same geologic materials, the variability observed in these parameters would not typically be expected. In the case of Fe, a difference from <0.04 mg/L in well OAL-04 to 10.5 mg/L in well OAL-03 suggests that there are localized areas of different water quality. However, a comparison of the upgradient monitoring well (OAL-04) analytical data to the remaining (downgradient) well analytical data does not demonstrate that the landfill is impacting groundwater for the constituents shown on Table 7.

5.0 CONCLUSIONS AND RECOMMENDATIONS

In the 2002 Phase II ESA, it was reported that there are widespread soil impacts within the landfill boundaries resulting in elevated metals and arsenic concentrations. The data supports the migration pathway of waste to soils: contaminants found in landfilled waste may migrate to surrounding soils. However, when comparing the targeted sampling and analysis of surface to subsurface soils, the results indicate lower metals concentrations at depth (generally near background surface soil levels).

Also during the 2002 Phase II ESA, it was found that there is a widespread distribution of pesticides contamination in soils within the landfill boundaries, with the area of Test Pit 4 (tar stained soil area) showing the highest concentrations of pesticides in soils. Targeted sampling of surface and subsurface soils at three locations just outside the tar stained soil area showed traces of pesticides in surface soils at one location, and no detection of pesticides at depth.

Targeted groundwater samples did not show the presence of CoCs. Water chemistry data from onsite wells indicates that groundwater beneath OAL has apparently elevated values of specific conductivity, sulfate (SO_4), and sodium (Na). The 2002 Phase II ESA results indicate that surface water from the oxbow pond and Milk River have SO_4 and Na occurring in similar proportions (2:1 ratio) as OAL groundwater, but over an order of magnitude lower in concentration than the groundwater values. It is uncertain whether the apparently elevated specific conductance, SO_4 and Na in groundwater beneath the landfill represent ambient conditions for that particular hydrostratigraphic unit, or if landfill wastes have impacted groundwater quality. Based on the chemical characterization, soil classification, and groundwater hydrology at the OAL, it appears that the pollutants found within the OAL boundaries are not particularly mobile but that “hot spots” exist, where higher concentrations of metals and/or pesticides can be found.

There is little evidence supporting migration of CoCs from contaminated soils to groundwater, or from groundwater to surface water or sediments. However, one sediment sample (OAL-SED3) shows arsenic (As) and lead (Pb) above EPA Region 9 PRGs and zinc (Zn) above the EPA soil screening level. Given that there are elevated levels of these metals in nearby surface soil samples, it could be that migration is occurring directly from surface soil to the oxbow pond sediments. The conceptual site model has been revised to include this migration pathway.

Field screening with the PID indicated the presence of volatile organic compounds (VOCs) at depth in the vicinity of groundwater monitoring well OAL-05. Past data did not warrant targeting VOC contaminants, so there is no analysis for VOCs in the groundwater or subsurface soils in this area. Sampling OAL-05 for VOCs is recommended.

Due to low concentrations and an apparent lack of mobility of any contaminants present, additional investigation would have limited value. Past and present sediment samples from the oxbow pond show elevated metals and arsenic levels; additional sediment samples would help delineate this concern but may not be sufficient to evaluate ecological risks. Institutional controls (signs, fencing, etc.) are recommended at this time, pending a general site cleanup. The FBIC’s OAL site restoration goals may be achieved by removing the rubble pile (and associated health and safety risks) followed by surface reclamation (regrading, topsoil and re-seeding).

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